Original Article

An investigation into the relationship between throw performance and maximum weight in weight training of female discus throwers

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ABSTRACT

The purpose of this study was to examine the relationship between female disc throwers' competitive performance and their maximum lifting weights. The study results were obtained via an internet survey targeting 37 female athletes specializing in the discus throw. Maximum lift weights from the bench press, the full squat, the dead lift, the high clean, and the snatch were recorded. Pearson's accumulated correlation coefficient was used to determine the association between competition performance and one repetition maximum. The results of the survey revealed that weights, there was a significant positive correlation between the performance of female discus throwers and their maximum lifting weight in the bench press, the high clean, and the snatch. Incidentally, there was a significant positive correlation between the height and the performance of female athletes. These results reveal the importance of the bench press and the clean and snatch among female discus throwers.
Keywords: Discuss throwers; Female Athletes; Weight training; Athletics.

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INTRODUCTION

The discus throw is a sport wherein the athletes employ rotation to project a disc and compete based on flight distance. Males and females use discs weighing 2.0 kg and 1.0 kg, respectively. Excluding the influence of the wind, the factors that determine the flight distance are the initial velocity at projection, the projection angle, and the projection height at release. Of these, the initial velocity of projection has the greatest effect on distance (Dapena, 1993; Hay and Yu, 1995; Gregor, 1985). Therefore, increasing this initial velocity of projection is one of the main goals in training.

The kinetics of the discus throw can be divided into a preparation phase (preparation), an entry phase (the first turn), an airborne phase (airborne), a transition phase (the second turn), a delivery phase (projection), and a reverse phase (the body returns to the original position) (Figure 1) (Bartlett, 1992). In the discus throw, power is exerted efficiently through complex operations that rely on technique and physical factors. Therefore, discus throw training emphasizes both of these factors. Various types of training are employed to enhance physical fitness, such as weight training, running, stretching, and plyometrics training. Because weight training is particularly important, a large amount of time is devoted to it.

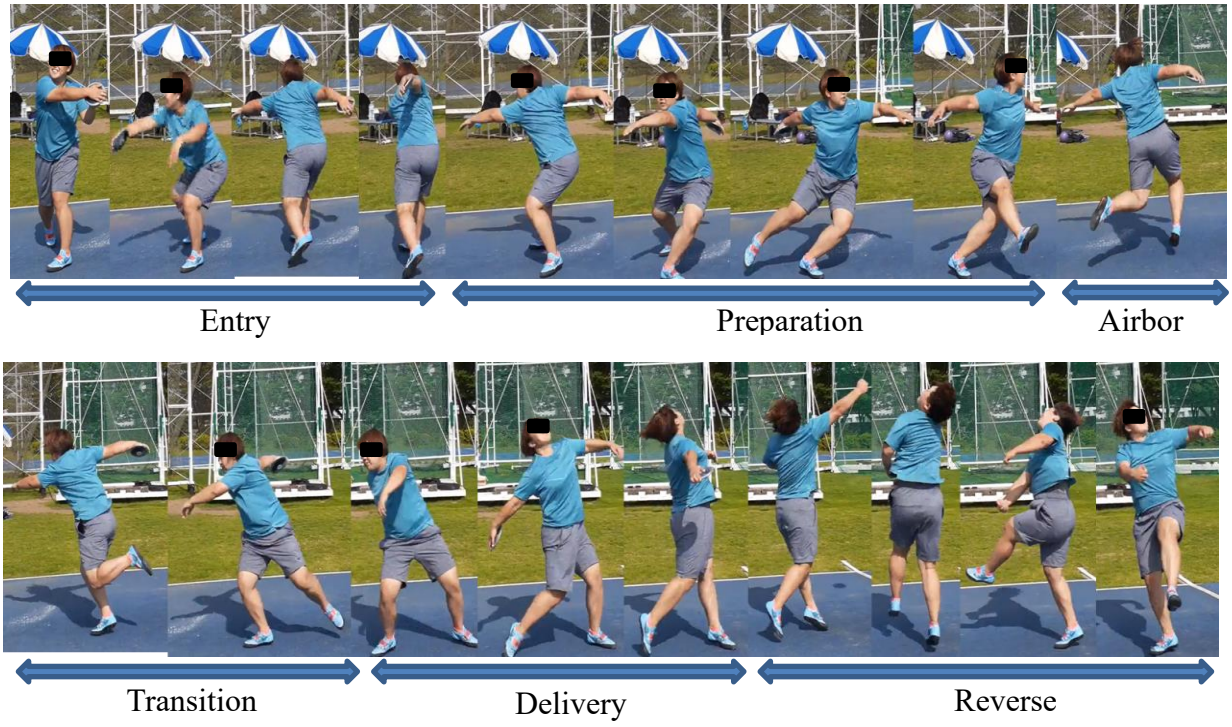

Figure 1. Phases of Discus throw.

A survey (Maeda et al., 2016) conducted in 114 male discus athletes in Japan reported a significant positive correlation between the one repetition maximum (1RM) of the bench press, the full squat, the clean, the snatch, and the dead lift and competition performance. Another study demonstrated that the greater the strength of the male discus thrower, the greater the 1RM of the high clean and the squat (Hatakeyama et al., 2011). These studies indicate that there is a significant relationship between heavy weight training and competitive advantage in males.

Many studies confirm the relationship between physical strength and athletic ability in males; however, few studies have been conducted in females. Previously, we examined the relationship between the physical strength and the competitiveness of female throwing athletes and observed the importance of the ability to exert power in a throwing event (Takanashi, 2010; Takanashi et al., 2009). While these studies measured the power of the bicycle ergometer and the shot back throw, they did not examine maximum lifting weights.

Studies of world-class athletes report sex-related differences in the technique and the physical parameters of discus Throwers (Leigh et al. 2008; Gregor, 1985). In Japan, differences in the speed of movement between males and females have been reported (Tauchi et al., 2007; Maeda et al. 2017). These differences in acceleration could be a result of the differing discus weights for males and females. Additionally, reports reveal that waist rotation begins earlier in females than in males (Yamamoto, 2015 b). These studies illustrate clear differences in both the disc throwing techniques and the physical strength between male and female discus athletes.

In spite of these sex-related differences, female discus athletes' training regimens are often based on the characteristics of their male counterparts. Universities have the opportunity to train both males and females and can conduct the male athletes' training based on physical strength characteristics that have been clarified. However, an examination of the physical strength characteristics of female discus athletes is required to establish training methods suitable for these athletes.

The purpose of this study was to clarify the relationship between female disc throwers' competitive performance and their maximum lifting weights.

METHOD

Participants

The study consisted of an internet questionnaire survey. The questions were designed to investigate the maximum lifting weights and competition performance records of discus throwers. The recovery rate of the questionnaire survey was 100% (37 surveys). The subject and the purpose of the research was explained to all of the participants and a signed written consent for the publication of the survey results was obtained from each one. Characteristics of the 37 female student discus throwers are shown in Table 1. The average age, height, weight, and years competing was 19.67 ± 1.14, 164.3 ± 4.73 cm, 68.05 ± 6.28 kg, and 6.29 ± 1.96 years, respectively. The self-best record was 42.79 ± 4.68 m, and the season best record was 42.35 ± 5.02 m.

Table 1 Characteristics of subjects.

Age (Year)	19.67 ± 1.27
PB (Personal Best Record)	42.79 ± 4.68
SB (Season Best Record)	42.35 ± 5.02
Experience (Year)	6.29 ± 1.96
Length (cm)	164.3 ± 4.73
Body mass (kg)	68.05 ± 6.28

Measures

We investigated the IRM of the bench press, the squat, the clean, the snatch, and the deadlift for each participant. The competition performance and the maximum weightlifting data were the season best (SB) records. The mean and the standard deviation of the subjects' age, personal best records (PB), SB records,

years of competition experience, height, weight, bench press, full squat, high clean, snatch, and dead lift 1RMs were calculated.

Design and procedures

The bench press was performed with both feet on the ground; however, there was no restriction on raising the legs while lifting. The use of straps was permitted in the clean and snatch. The dead lift began with the barbell on the floor and was successfully completed when both knees were completely stretched.

Statistical analyses

An unpaired t-test was used to test for statistical sex-related differences in the data. Pearson's accumulated correlation coefficient was used to determine the association between competition performance and 1RM. The statistical significance was set at < 5%.

RESULTS

The average 1RMs of the bench press, the full squat, the high clean, the snatch, and the dead lift to be 76.76 ± 14.99 kg, 95.9 ± 17.71 kg, 78.38 ± 14.53 kg, 51.6 ± 13.91 kg, and 110.34 ± 40.13 kg, respectively. Weight training 1RM includes SB, bench press ($r = .559$, $p < .05$), high clean ($r = .647$, $p < .01$), and snatch ($r = .586$, $p < .05$). The higher the SB, the larger the 1 RM (Figures 2, 3, and 4).

There was a significant ($r = .536$, $p < .05$) positive correlation between SB and height of the subjects (Figure 5).

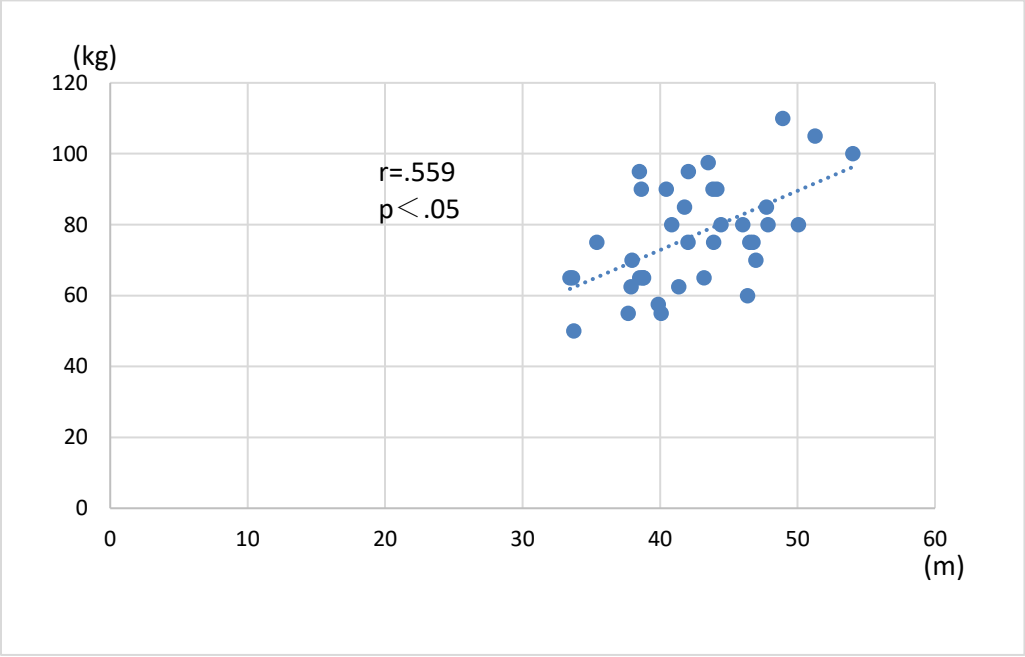

Figure 2. Relationship of 1RM bench press and throw distance.

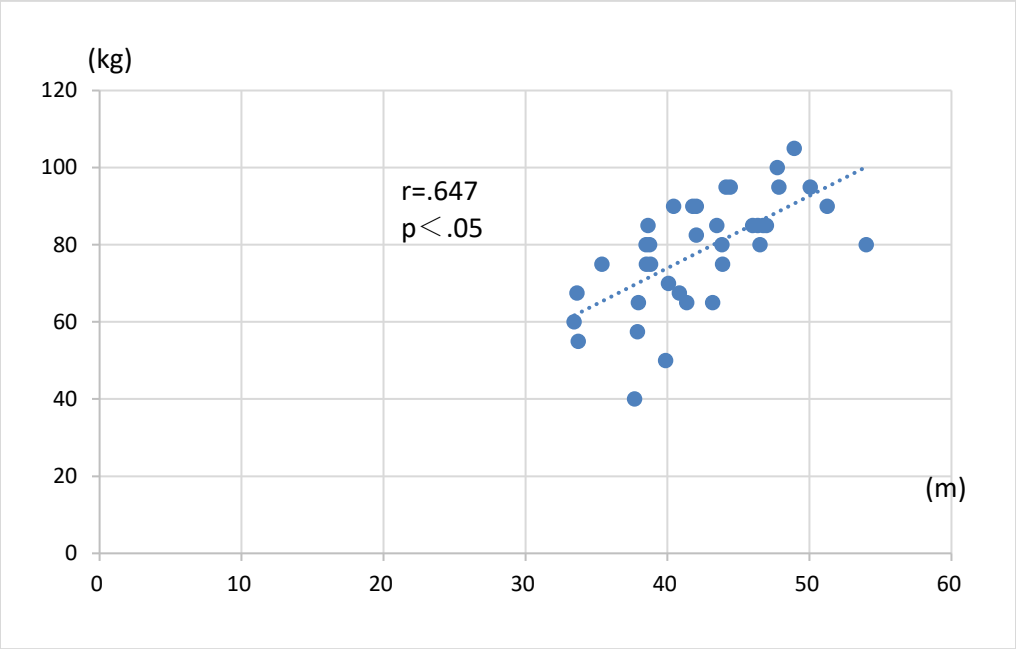

Figure 3. Relationship of 1RM high clean and throw distance.

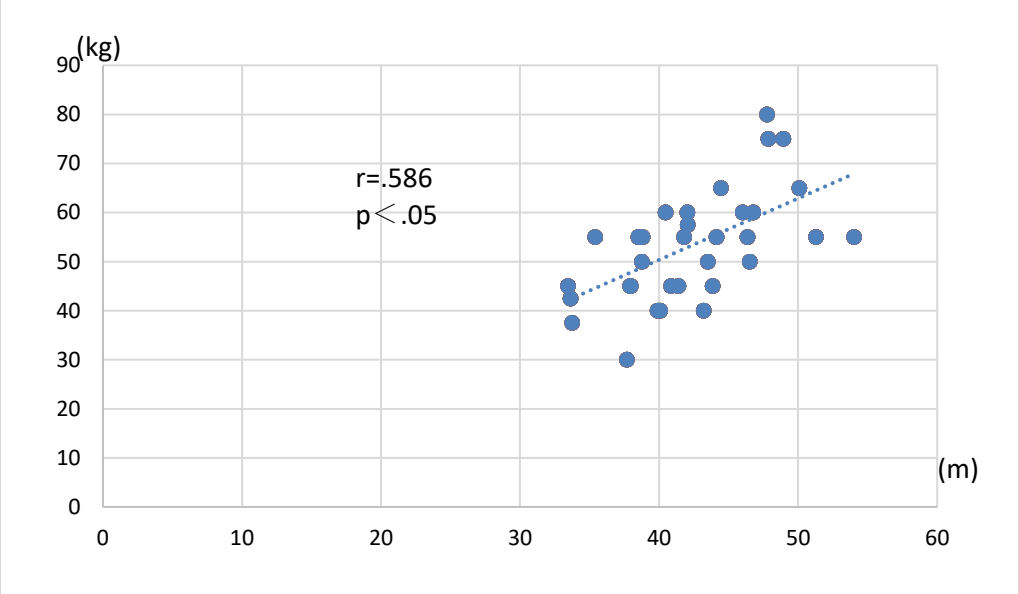

Figure 4. Relationship of 1RM snatch and throw distance.

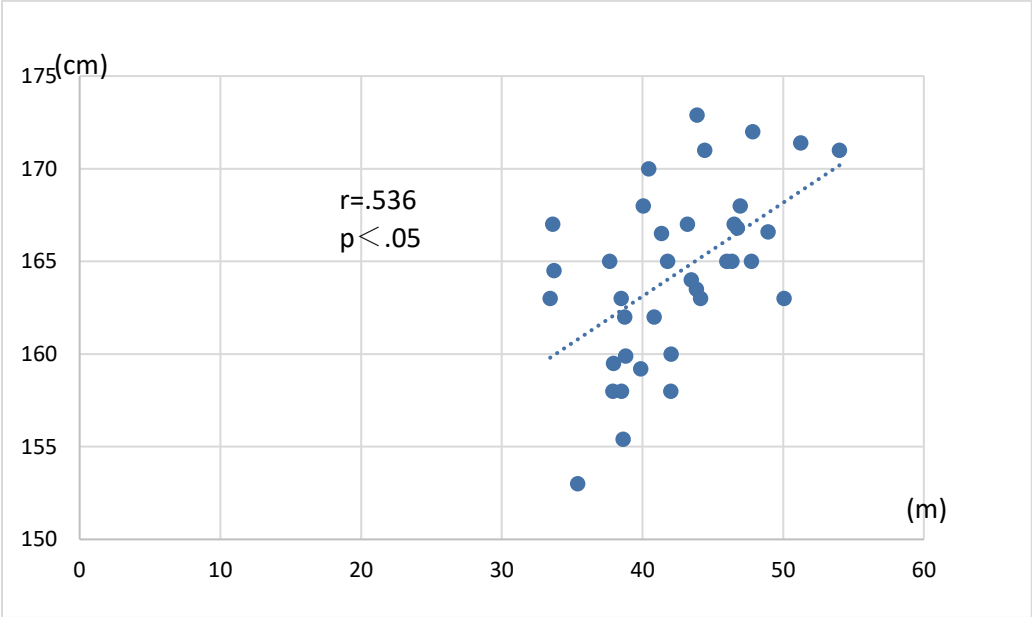

Figure 5. Relationship of height and throw distance.

DISCUSSION AND CONCLUSIONS

Previous studies have revealed a significant correlation between heavy weight training and competitive performance in male discus throwers. However, few studies have been performed for female discus throwers. Despite confirmed sex-related differences, both male and female discus athletes have similar training regimens. The purpose of this study was to examine the relationship between weight training and competitive performance in female discus throwers.

This study showed a significant positive correlation between competitive ability and the bench press, the high clean, and the snatch 1RM. Although this study found a significant positive correlation between maximum bench press weight and competitiveness in females, a previous study of men's discus athletes reported that the bench press should not be evaluated because it can also be performed by exerting power slowly (Hatayama et al. 2011). However, this is deeply related to the level of competition of the target person and how well they achieve speed.

It has been reported that 68% of the projected disk speed is determined in the delivery phase (Figure 1-Delivery Phase) (Hay and Yu, 1995). Female discus throwers weigh less than the male throwers; therefore, females require a greater speed to transmit the same level of force. The action of the high clean and the snatch could contribute to the output of power in the delivery phase. The high clean requires an efficient transmission of power from the lower limbs to the upper limbs. The explosive effort required to raise the barbell from the floor could correlate to the explosive movement of the delivery phase (Figure 1).

No significant correlation was found between competitive ability and the full squat or the deadlift 1RM. Therefore, it is considered that instantaneous leg extension was not reflected in the result. Generally, squats and dead lifts exert great force at low speeds, while instantaneous actions are required for clean and snatch operations.

Since the present study examined only the maximum lifting weight, no relationship with competition ability was found.

This study also suggests that placing an emphasis on the ballistic behaviour of the whole body may be an important method of training female disc athletes. Furthermore, future studies examining ballistic motion weight training such as bench press with parabolic motion and jump squats are needed.

Additionally, a significant positive correlation was found between height and performance. Wide shoulders and long arms are advantageous to these athletes because they result in a large centrifugal force that can be applied to the object. However, a previously conducted study reported that no significant correlation was found between the arm length and the ability of Japanese male discus throwers (Hatayama et al. 2011).

It is considered that females have an advantage in accelerating their placement rather than males because of the higher proportion of body weight to the placement. The longer the arm, the more it can benefit from centrifugal force. Conversely, the larger the centrifugal force, the larger the force applied to the fulcrum (shoulder and chest). Therefore, a male with a smaller body mass needs a large joint torque to shake off at the time of release. This indicates an increased reliance on muscle strength around the shoulders and chest in males.

Conversely, women who are heavy in weight in relation to the disc have less reliance on muscle strength, and it is predicted that arm length has a direct effect on distance. A tall competitor is likely to have a long arm length, and it is presumed that this characteristic would show a significant positive correlation with competition performance. A large joint torque is required for shoulder joints because of the long arm length in addition to the heavier disc weight in males (Terzis et al. 2007). However, it was suggested that women could use the rotational movement of the trunk and upper limb positively because of the smaller discus weight. Therefore, the variation in physical strength of males and females could be derived from a diversity in technique due to the difference in disc weight. However, these considerations do not measure the finger position of female athletes. The relationship between height and ability may negate the need for greater upper body strength in tall athletes. Short athletes may also need to concentrate on muscle training more than tall athletes. To clarify this, more specific research will need to focus on women's height, 1RM, and ability.

As mentioned above, in this study, interesting data on the relationship between physical characteristics and performance were obtained. However, the purpose of this study was to study the lifting weight in weight training. The relationship between the physical characteristics of female disc players and the ability to compete requires further investigation.

The study had some limitations. This study was conducted based on athlete self-reports. Moreover, the confirmation of the detailed lifting form of each athlete was not possible. Therefore, there is a risk that individual differences in the lifting form may be present. Another disadvantage was the small number of subjects. This is, in part, due to the limited number of female discus athletes in Japan. Although these limitations do exist, studies focusing on "lifting weight and throwing performance of female athletes" are rare. Hence, these important results could form the basis of future research.

This study revealed a significant association between bench press, the high clean, and the snatch's 1RM and competition performance in female disc throwers. These results emphasize the importance of weight training in this group of athletes. This study also indicates the need for further studies into the relationship between

individual characteristics such as height and competitiveness in athletes. The more understanding, we have of the mechanics indicative of success, the better able we will be to construct more tailored training regimens.

AUTHOR CONTRIBUTIONS

Study concept and design, drafting the article and its critical revision: Yuta Takanashi. Data collection and analysis, final approval of the version to be published; Natsumi Fujimori. Conception and design of the study, data analysis and interpretation, final approval of the version to be published; Natsue Koikawa.

SUPPORTING AGENCIES

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DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

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